BOARD OF ADJUSTMENT AGENDA
REGULAR MEETING
MONDAY, AUGUST 29, 2016

MEETING: 4:30 P.M. - CITY COUNCIL CHAMBERS

1. Call to Order.

2. Roll Call.

3. Dispense with the reading and approve the minutes of the April 25, 2016, Regular Meeting as prepared.

4. Hear and decide on an Administrative Appeal, made by appellant Mark Boschult, pertaining to the interpretation of Fremont Zoning Ordinance, Article 2 Definitions, and more specifically Subsection 212.1., the definition of Impervious Coverage.

5. Adjournment.

THIS MEETING WAS PRECEDED BY PUBLICIZED NOTICE IN THE FREMONT TRIBUNE, THE AGENDA DISPLAYED IN THE LOBBY OF THE MUNICIPAL BUILDING AND POSTED ONLINE AT WWW.FREMONTNE.GOV IN ACCORDANCE WITH THE NEBRASKA OPEN MEETINGS ACT, A COPY OF WHICH IS POSTED CONTINUALLY IN THE COUNCIL CHAMBERS FOR PUBLIC INSPECTION, AND SAID MEETING IS OPEN TO THE PUBLIC. A COPY OF THE AGENDA WAS ALSO KEPT CONTINUALLY CURRENT AND AVAILABLE TO THE PUBLIC IN THE PRINCIPLE OFFICE OF THE DEPARTMENT OF PLANNING, 400 EAST MILITARY AVENUE. THE BOARD OF ADJUSTMENT RESERVES THE RIGHT TO ADJUST THE ORDER OF ITEMS ON THIS AGENDA.

BOARD OF ADJUSTMENT MINUTES
REGULAR MEETING
APRIL 25, 2016 – 4:30 PM

PRESENT: Chairman Brad Fooken, Board Members, Phil Bang, Gary Bolton, and Skip Sawyer, City Attorney Paul Payne, and Planning Director Troy Anderson

ABSENT: Board Member Scott Brown

1. Call to Order. Chairman Fooken called the meeting to order at 4:30 p.m.

2. Roll Call. A roll call showed four (4) members present, and one (1) member absent – a quorum was established.

Chairman Fooken then read the following statement: This meeting was preceded by publicized notice in the Fremont Tribune, the agenda displayed in the lobby of the Municipal Building and posted online at www.fremontne.gov in accordance with the Nebraska open meetings act, a copy of which is posted continually in the council chambers for public inspection and said meeting is open to the public. A copy of the agenda was also kept continually current and available to the public in the principle office of the Department of Planning, 400 East Military Avenue. The Board of Adjustment reserves the right to adjust the order of items on this agenda. This meeting is hereby declared to be duly convened and in open session.

3. Dispense with the reading and approve the minutes of the January 25, 2016, Regular Meeting as prepared.

   Chairman Fooken read the item into the record. Hearing no discussion, Fooken entertained a motion.

   Motion: It was moved by Member Bolton, and seconded by Member Bang, to dispense with the reading of the minutes and approve the minutes as provided. A roll call vote showed all members present voting aye – the motion carried unanimously.

4. Dispense with the reading and approve the minutes of the March 22, 2016, Special Meeting as prepared.

   Chairman Fooken read the item into the record. Hearing no discussion, Fooken entertained a motion.

   Motion: It was moved by Member Bang, and seconded by Member Bolton, to dispense with the reading of the minutes and approve the minutes as provided. A roll call vote showed all members present voting aye – the motion carried unanimously.

5. Consider a request of St. Timothy Lutheran Church, the owner of approximately 1.7 acres located at 538 W 16th St., for approval of a Variance to Table 10-3,

Fremont Zoning Ordinance, pertaining to Maximum Permitted Area for signs, particularly as it relates to a civic use in a residential zoning district.

Chairman Fooken read the item into the record. Fooken then proceeded to open the floor to appellant arguments.

Pastor Russ McDowell, representative of the applicant, informed the Board that St. Timothy Lutheran Church occupies the former seminary building and that all of the parking is on the west side of the building. Pastor McDowell continue to explain that a sign is located on the corner of N. Nye Ave. and W 16th St. but that 90% use the west entrance. They are asking for a variance to put signage on the building to direct people into the facility. Hearing no further comments from the appellant, Fooken closed the floor to appellant arguments and proceeded to open the floor to public hearing.

Hearing nothing from the public, Fooken closed the floor to public hearing and opened the floor to appellee arguments.

Planning Director Anderson submits Staff's Report and recommended disapproval as the hardship claimed by the applicant was both self-inflicted and without hardship. Hearing no further comments from City Staff, Fooken closed the floor to appellee arguments and opened the floor to Board discussion and action.

The Board discussed the various arguments. Hearing no further discussion, Fooken entertained a motion.

Motion: It was moved by Member Bang, and seconded by Member Bolton, to approve the request with the condition that letters be ten (10) inches in height. A roll call vote showed three (3) members voting aye and one (1) member, Chairman Fooken, voting nay – the motion failed.

6. Adjournment

Hearing no further business, Chairman Fooken adjourned the meeting at approximately 5:05 p.m.

APPROVED:

____

Brad Fooken, Chairman

ATTEST:

____

Troy Anderson, Planning Director

Staff Report

TO: Board of Adjustment

FROM: Troy Anderson, Director of Planning

DATE: August 18, 2016

SUBJECT: Administrative Appeal – Impervious Cover

Background: Mark Boschult, appellant, is appealing the interpretation of Fremont Zoning Ordinance (FZO), Article 2 Definitions, and more specifically Subsection 212.1., the definition of Impervious Coverage. FZO subsection 212.1 reads, "Impervious coverage: The total horizontal area of all buildings, roofed or covered spaces, paved surface areas, walkways and driveways, and any other site improvements that decrease the ability of the surface of the site to absorb water, expressed as a percent of site area. The surface water area of pools is excluded from this definition." Mr. Boschult would like the City to consider drainage coefficients for determining compliance with impervious coverage and exclude prior improvements from contributing to impervious coverage. We contend that the definition, despite whether or not it could or should, unfortunately provides neither an option for fractional consideration, nor does it provide an option for exclusion based on time or place and that there is simply either improvement that contributes to impervious coverage or there is not.

More specifically, on April 8, 2016, the appellant submitted site development plans for the expansion of his existing business. After review of the site development plans, it was determined that the plans could be conditionally approved so long as, "all of [the subject property] be replatted into one (1) lot …, and you are able to demonstrate compliance with the maximum impervious coverage requirement prior to issuance of a building permit." In response, the appellant provided "Iowa [Department of Transportation] DOT 10 year runoff coefficients." It was then explained to the appellant that runoff coefficients, like those found in the Iowa's DOT Design Manual are "for most roadway stormwater drainage systems … used to determine peak flow (Q)" (Iowa DOT Design Manual, Chapter 4, Drainage, *Using the Rational Method to Determine Peak Flow*, pg. 1) and not for determining the pervious or impervious coverage of a lot or tract. The Zoning Administrator subsequently rejected the appellant's claim that the proposed site development plans comply with the maximum impervious coverage requirements. Mr. Boschult has appealed, arguing that the definition of impervious coverage, as that term is defined by the Fremont Zoning Ordinance, "needs clarification."

In response to the appellant's letter, Staff has prepared the following:

- The appellant argues that "the attached Engineer Stamped Calculations were submitted using the Iowa DOT 10 year runoff coefficients for the rational method of calculating and came well within requirements at 61% impervious." Unfortunately, drainage coefficients, like the ones provided, are used for sizing "most roadway stormwater drainage systems" (Op. cit., pg. 1) and not for determining whether or not site improvements contribute to the impervious coverage of a lot or tract – they're two dissimilar subjects.

- The appellant argues that, "the first part of the definition is extremely clear identifying building structures and paving as impervious," but that "the balance of the definition: 'any other site improvements that decrease the ability of the surface of the site to absorb water,' needs clarification." He continues to argue that site improvements that "decrease the ability of the surface of the site to absorb water" lack relation to a value or condition and therefore any site improvements that do not decrease the ability of the existing surface to absorb water, should not be included in the impervious area. The claim is that previous improvements (i.e. a gravel parking lot built in the 1950's) should not contribute to impervious coverage because the improvements were not made by the appellant.

  We would argue that the ability of the surface of the site to absorb water does relate to a value or condition, that being the natural undisturbed condition of the site. According to subsection 203, FZO, "Where terms are not specifically defined, their ordinarily accepted meaning or meanings implied by their context shall apply." We submit the following definitions from the American Planning Association (APA) Planning Advisory Service (PAS) Report Number 521/522, more commonly referred to as "A Planners Dictionary" for your consideration:

  > *Impervious surface* - ***<u>Any</u>*** hard-surfaced, ***<u>man-made</u>*** area that does not readily absorb or retain water, ***<u>including</u>*** but not limited to building roofs, ***<u>parking and driveway areas</u>***, ***<u>graveled areas</u>***, sidewalks, and paved recreation areas. (Lake County, Ill.)
  >
  > *Impervious surface* - ***<u>Any</u>*** nonvertical surface ***<u>artificially</u>*** covered or hardened so as to prevent or impede the percolation of water into the soil mantle, ***<u>including</u>*** but not limited to roof tops excepting eaves, swimming pools, ***<u>paved or graveled roads, and walkways or parking areas</u>*** and excluding landscaping, surface water retention/detention facilities, access easements serving neighboring property, and driveways to the extent that they extend beyond the street setback due to location within an access panhandle or due to the application of [county] requirements to site features over which the applicant has no control. (King County, Wash.)

> *Impervious surface* - ***<u>Any</u>*** material that substantially reduces or prevents the infiltration of stormwater into ***<u>previously undeveloped land</u>***. "Impervious area" shall include ***<u>graveled driveways and parking areas</u>***. (Sandy, Ore.)

As indicated, gravel and gravel improvements are clearly impervious cover. Neither the City's definition nor any other common definition of impervious cover makes the distinction as to whether an improvement is pervious or impervious based on when the improvement is made but rather that an improvement is made. In other words, the "gravel parking lot built in the 1950's" was a man-made, artificial, improvement to an otherwise natural and undisturbed tract of land and therefore contributes to the impervious coverage of the site. Even the appellant acknowledges this fact to some degree when he wrote, "all site improvements affect the ability of the surface to absorb water." As previously suggested, the question isn't *when* the improvement was made, but rather *that* an improvement was made.

- Again, the appellant argues that runoff coefficients consider the surface, compaction and grades when calculating runoff and that use of such eliminates the ambiguity created by the definition of impervious coverage. And as previously indicated, we would argue that runoff coefficients are used for the sizing of roadway stormwater drainage systems and the peak flow of stormwater runoff and not for determining whether or not site improvements contribute to the impervious coverage of a lot or tract – they're apples and oranges. We would further contend that the definition of impervious coverage, as that term is defined by the Fremont Zoning Ordinance, is not ambiguous but rather plain language and unambiguous as well as consistent with other definitions of the same.
- Lastly, both Nebraska Revised Statutes (NRS), section 19-910, and FZO § 1209.a., requires the appellant to identify where the administrative official has erred in the "order, requirement, decision, or determination." The definition of impervious coverage simply differentiates between that which is improved, and, by virtue of omission, that which is unimproved. Arguing that a drainage coefficient could be used or should be used to determine whether an improvement is fractionally permeable or not does not constitute error on the part of the official. And simply arguing that someone else made the improvement does not constitute error on the part of the official. The definition provides neither an option for fractional consideration, nor does it provide an option for time or place – there is either improvement or there is not.

Staff recommends affirmation of the Zoning Administrator's order, requirement, decision, or determination based on the arguments made herein. In order to reverse the Zoning Administrator's order, requirement, decision, or determination and find for the appellant, the Board must find that the Zoning Administrator erred in his order, requirement, decision, or determination, and as acting officer/zoning administrator make such order, requirement, decision, or determination as ought to be made. Please note, where it is found that the Zoning Administrator erred in his order, requirement, decision, or determination, the Board's action shall become the policy and practice for future orders, requirements, decisions, or determinations, on all properties within the jurisdiction and extraterritorial jurisdiction of the City, regardless of conditions.

Nebraska Revised Statutes relating to the Board of Adjustment and Administrative Appeals

NRS section 19-907 requires the local legislative body [enforcing zoning regulations] to provide for the appointment of a board of adjustment (Board) – any action of which shall not exceed the powers granted to it by the State. NRS section 19-910, and similarly FZO § 1209.a., details the powers of the Board as follows:

> (1) The board of adjustment shall, subject to such appropriate conditions and safeguards as may be established by the legislative body, have only the following powers: (a) To ***hear and decide appeals*** ***when it is alleged there is error*** ***in any order, requirement, decision, or determination made by an administrative official*** or agency based on or made in the enforcement of any zoning regulation or any regulation relating to the location or soundness of structures, except that the authority to hear and decide appeals shall not apply to decisions made under subsection (3) of section 19-929; (b) to hear and decide, in accordance with the provisions of any zoning regulation, requests for interpretation of any map; and (c) when by reason of exceptional narrowness, shallowness, or shape of a specific piece of property at the time of the enactment of the zoning regulations, or by reason of exceptional topographic conditions or other extraordinary and exceptional situation or condition of such piece of property, the strict application of any enacted regulation under this section and sections 19-901, 19-903 to 19-904.01, and 19-908 would result in peculiar and exceptional practical difficulties to or exceptional and undue hardships upon the owner of such property, to authorize, upon an appeal relating to the property, a variance from such strict application so as to relieve such difficulties or hardship, if such relief may be granted without substantial detriment to the public good and without substantially impairing the intent and purpose of any ordinance or resolution.
>
> (2) No such variance shall be authorized by the board unless it finds that: (a) The strict application of the zoning regulation would produce undue hardship; (b) such hardship is not shared generally by other properties in the same zoning district and the same vicinity; (c) the authorization of such variance will not be of substantial detriment to adjacent property and the character of the district will not be changed by the granting of the variance; and (d) the granting of such variance is based upon reason of demonstrable and exceptional hardship as distinguished from variations for purposes of convenience, profit, or caprice. No variance shall be authorized unless the board finds that the condition or situation of the property concerned or the intended use of the property is not of so general or recurring a nature as to make reasonably practicable the

formulation of a general regulation to be adopted as an amendment to the zoning regulations.

(3) ***In exercising the powers granted in this section***, ***the board may***, in conformity with sections 19-901 to 19-915, ***reverse or affirm, wholly or partly, or may modify the order, requirement, decision, or determination appealed from***, and may make such order, requirement, decision, or determination as ought to be made, ***and to that end shall have all the powers of the officer from whom the appeal is taken***. ***The concurring vote of four members of the board shall be necessary to reverse any order, requirement, decision, or determination of any such administrative official, or to decide in favor of the applicant on any matter upon which it is required to pass under any such regulation or to effect any variation in such regulation***.

FZO, Subsection 1209.a., reads, "To hear and decide appeals where it is alleged there is ***error*** in any order, requirement, decisions or determination made by the Zoning Administrator, or his/her designee in the enforcement of these regulations or any regulation relating to the location or soundness of structures." [***emphasis added***]

Fiscal Impact: N/A

Exhibit A1

CITY OF
FREMONT
NEBRASKA PATHFINDERS

Planning & Development
400 E. Military Ave.
Fremont, NE 68025
Phone: 402-727-2636
Fax: 402-727-2659

APPEAL/EXCEPTION/VARIANCE APPLICATION

APPLICATION TYPE

☒ Administrative Appeal
☐ Special Exception (*including interpretation of any map*)
☐ Variance

APPLICANT (*all correspondence will be directed to the applicant*)

Name BOSCHULT, MELVIN W & ANNE T. TRUSTEE Phone 402-721-1017
Address P.O. BOX 1238 Fax 402-721-6583
City FREMONT State NEBRASKA Zip 68026
Email BEC@OMNI-TECH.NET

PROPERTY OWNER (*if not the same as applicant above*)

Name ____ Phone ____
Address ____ Fax ____
City ____ State ____ Zip ____
Email ____

ENGINEER, SURVEYOR, OR ARCHITECT (*if not the same as applicant above*)

Name CLARK BOSCHULT Phone 402-720-5719
Address ____ Fax ____
City ____ State ____ Zip ____
Email ____

AGENT (*if not the same as applicant above*)

Name ____ Phone ____
Address ____ Fax ____
City ____ State ____ Zip ____
Email ____

(*application continued on next page*)

Exhibit A2

CITY OF
FREMONT
NEBRASKA PATHFINDERS

Planning & Development
400 E. Military Ave.
Fremont, NE 68025
Phone: 402-727-2636
Fax: 402-727-2659

APPEAL/EXCEPTION/VARIANCE APPLICATION

PROPERTY INFORMATION

Address of Property 500 N PIERCE STREET

General Location (*If no address is available*) ______________________

Brief Legal Description of Property ALL OF BLOCKS 1 & 2 AND VACATED 6TH STREET LYING BETWEEN SAID BLOCKS 1 & 2, ALL IN DOCKSTADER'S ADDITION TO THE CITY OF FREMONT, DODGE CO., NE.

Description of Request (*the following does not satisfy the "statement" requirement as described herein; a separate "statement" is required to be considered complete*) APPEAL THE CITY PLANNERS DECISION THAT THE SITE PLAN SUBMITTED WITH ENGINEERS STAMPED CALCULATIONS DOESN'T MEET THE MAXIMUM IMPERVIOUS COVERAGE REQUIREMENT ACCORDING TO TABLE 4-3 OF THE FREMONT ZONING ORDINANCE.

An application may be filed only by the owner(s) of the property, or duly authorized officer or agent of the owner(s). By executing this application, he/she does hereby acknowledge the above statements to be true and accurate to the best of their knowledge, and understand that knowing and willful falsification of information will result in rejection of the application and may be subject to criminal prosecution.

I have received, read and understand the terms and conditions of this request, and agree to compliance with all applicable codes and ordinances of the City.

* ORIGINALLY SUBMITTED 5/20/16

Signature	Print Name	Date
[signature] TRUSTEE	MARK T. BOSCHULT	7/28/16

Office Use Only

Submittal Date ______________ Project No. ______________

Payment Amount ______________ Receipt No. ______________

Other Comments ______________________

Exhibit B1

(6)

FILED

BOOK 2007 PAGE 2131

2007 APR -6 AM 10: 17

Carol Givens
DODGE COUNTY
REGISTER OF DEEDS
COMPARE INDEX FEE $ 27.00

NEBRASKA DOCUMENTARY
STAMP TAX
Date
$ E.17 By CM

WARRANTY DEED

KNOW ALL MEN BY THESE PRESENTS:

THAT We, Mervin W. Boschult and Anne T. Boschult, husband and wife, herein called the Grantor whether one or more, in consideration of One Dollar ($1.00) and other valuable consideration received from Grantee, does hereby grant, bargain, sell, convey and confirm unto Mervin W. Boschult, Trustee, and Anne T. Boschult, Trustee, to each an undivided one-half interest as tenants in common, herein called the Grantee whether one or more, the following described real property in Dodge County, Nebraska:

See Exhibit A attached hereto and incorporated herein by reference as if fully set forth.

To have and to hold the above described premises together with all tenements, hereditaments and appurtenances hereto belonging unto the Grantee's heirs and assigns forever.

And the Grantor does hereby covenant with the Grantee and with Grantee's heirs and assigns that Grantor is lawfully seised of said premises; that they are free from encumbrances that Grantor has good right and lawful authority to convey the same; and that Grantor warrants and will defend the title to said premises against the lawful claims of all persons whomsoever.

Dated: ~~February~~ March 20, 2007.

Mervin W Boschult
Mervin W. Boschult

Anne T Boschult
Anne T. Boschult

STATE OF NEBRASKA)
)SS
COUNTY OF DODGE)

The foregoing instrument was acknowledged before me on ~~February~~ March 20, 2007, by Mervin W. Boschult and Anne T. Boschult, husband and wife.

Notary Public

GENERAL NOTARY-State of Nebraska
THOMAS B. THOMSEN
My Comm. Exp. Sept. 8, 2008

Exhibit B2

EXHIBIT A

Lots 7 & 8, Block 1, Parkview Second Addition to the City of Fremont, Dodge County, Nebraska;

and

Lots One(1), Two(2), Three(3) and Four(4), in Block one (1) and Lots One(1), Two(2), Three(3), Four(4), Five(5), Six(6) and Seven(7), in Block two(2), all in Dockstader's Addition to the City of Fremont; together with that portion of Sixth Street between the east margin of Pierce Street and the West margin of the Chicago, Burlington & Quincy right-of-way, all in Dodge County, Nebraska;

and

Lot 9, Block 14, Hawthorne Heights proposed Second Addition to the City of Fremont, Dodge County, Nebraska.

Exhibit C

July 28, 2016
City of Fremont
c/o The Board of Adjustment
400 E. Military Ave.

Re: General Self Storage Appeal of the City Planner's interpretation of compliance with the maximum impervious coverage requirement in Table 4-3 of the Zoning District Regulations.

Dear Members of the Board,

General Self Storage submitted a site plan for approval to expand the Outside Vehicle Storage Area at 500 N. Pierce Street to Military Ave. The City Planner conditionally approved the site plan if compliance with Table 4-3 Maximum Impervious Coverage could be demonstrated. The attached Engineer Stamped Calculations were submitted using the Iowa DOT 10 year runoff coefficients for the rational method of calculating and came well within requirements at 61% impervious. The City Planner did not accept our calculations noting the definition of impervious coverage does not provide for drainage coefficients.

The definition of Impervious Coverage in Article 2 states "The total horizontal area of all buildings, roofed or covered spaces, paved surface areas, walkways and driveways, and any other site improvements that decrease the ability of the surface of the site to absorb water, expressed as a percent of the site area." The first part of the definition is extremely clear identifying building structures and paving as impervious. The balance of the definition: "any other site improvements that decrease the ability of the surface of the site to absorb water," needs clarification. The question is; "decrease the ability" relative to what value or condition? Does the Article 2 definition refer to the ability of the existing site conditions prior to making the proposed site improvements? If so, the proposed site improvements do **not** decrease the ability of the existing surface to absorb water and should **not** be included in the impervious area, thus the site plan submitted complies with the Table 4-3 requirement. The entire surface of the proposed New Outside Vehicle Storage is a gravel parking lot built in the 1950's.

All site improvements affect the ability of the surface to absorb water. The Iowa DOT Runoff Coefficients consider the surfaces, compaction and grades when calculating runoff. They eliminate the ambiguity created by the Article 2 definition of Impervious Coverage and should be accepted as clarification.

Hopefully these facts will expedite the approval of the attached Site Plan which includes a 15' landscape buffer along Military required by Article 8: Landscaping and Screening Standards and the February 27, 2012 Board of Adjustment approval as recommended by the Planning Commission. It should be noted, this site requires 17' more landscaping along Military than properties west of Pierce Street, due to the 100' right of way.

Approval of this project as submitted will bring a significant aesthetic improvement for the intersection of Military and Pierce and we're excited to make it happen. Thank you for your consideration.

Sincerely,

Mark Boschult

Mark Boschult
Trustee

Exhibit D

IOWA DOT - 2015 10YR STORM "C" RUNOFF COEFFICIENT

LOT = 154,266 SF

CITY CODE		"C"	WT'D "C"
PAVED -	90%	0.95	0.8550
LAWNS -	10%	0.22	0.0220
	100%		0.8770 - MAX

SITE	AREA	% SITE	"C"	WT'D "C"
PAVED	24,495 SF	15.88	0.95	0.1509
BLDG	35,566	23.05	0.95	0.2190
GRASS	6400	4.15	0.22	0.0091
	66,461	43.08 ✓	—	
GRAVEL	87,805	56.92	0.50	0.2846
	154,266 SF	100.00		

0.6636 < 0.8770 OK ✓

0.6636 = 61% IMPERV

		"C"
PAVED	60%	0.95
LAWNS	40%	0.22
	60/40 =	0.6580

REGISTERED PROFESSIONAL ENGINEER
CLARK ALLEN BOSCHULT
E-4545
STATE OF NEBRASKA

4-25-1

Exhibit E

Table 1: Runoff coefficients for the Rational Method.

description of area	runoff coefficient (C)***			
	5 year	10 year	50 year	100 year
Paved Surfaces/Buildings	0.94	0.95	0.98	0.98
Gravel Surfaces, Compacted	0.45	0.50	0.55	0.60
Gravel Surfaces, Loose Graded or Not Compacted	0.35	0.40	0.45	0.50
Industrial Light, 60% Impervious	0.64	0.69	0.79	0.83
Industrial Heavy, 75% Impervious	0.76	0.79	0.86	0.89
Commercial/Business Areas, 85% Impervious	0.81	0.85	0.91	0.92
Residential Row houses/town houses, 65% Impervious	0.66	0.67	0.74	0.76
Residential 1/4 Acre lots, 40% Impervious*	0.48	0.49	0.58	0.62
Residential 1/2 Acre lots, 25% Impervious*	0.36	0.39	0.49	0.54
Residential 1 Acre lots, 20% Impervious*	0.32	0.34	0.46	0.51
Lawn, 0 to 2% slope (flat) **	0.22	0.22	0.30	0.36
Lawn, 2 to 7% slope (average) **	0.24	0.25	0.35	0.40
Lawn, 7% or greater (steep) **	0.26	0.30	0.38	0.45
Parks/Golf Courses/Cemeteries, 8% Impervious	0.21	0.21	0.28	0.34

* Based on Type B soils. Some regions in Iowa have predominant C and D type soils which require larger 'C' values. Appropriate experience is required in selecting appropriate 'C' values. Contact Office of Design Soils Section for further guidance.

** Based on heavy soils and lawn in fair condition. For situations involving sandy soils, contact the Methods Section

*** For higher percent of imperviousness than in the "description of area", developing land with no cover to poor cover, compacted soils, locations of high water table, and/or soils having a slow infiltration rate when thoroughly wetted, these values may be too low. Consult HEC-22, AASHTO Drainage Design Guidelines, or the Methods Section.

If future land use is unknown, the runoff coefficient should be conservatively based.

Occasionally a single C value can adequately describe an entire project or area. Typically, a different C value is required for each inlet and composite C values are often required. When a drainage area is composed of more than one distinct part, use the weighted average equation below to find a composite C.

$$C = \frac{C_1A_1 + C_2A_2 + C_3A_3 ... + ... C_nA_n}{A_1 + A_2 + A_3 ... + ... A_n} \quad \text{(Equation 4A-5\_2)}$$

where:

$A_1, A_2, A_3, \ldots A_n$ = areas of the distinct parts.

C_1 = C value for A_1, C_2 = C value for A_2, etc.

Example Problem 4A-5_1, Determining Composite C

Rainfall Intensity (I)

Rainfall intensity (I) is the average rate of rainfall given in in/hr that occurs over the duration of a storm. Rainfall intensity is required to use the Rational method. To calculate I, the designer must first select a recurrence interval (T_R). Next the designer calculates the time of concentration (T_c). Once T_R and T_c are known, I is determined using Table 2 (for the Rational method, storm duration is the same as T_c). Often, T_c falls between the values in the tables, so I needs to be interpolated.

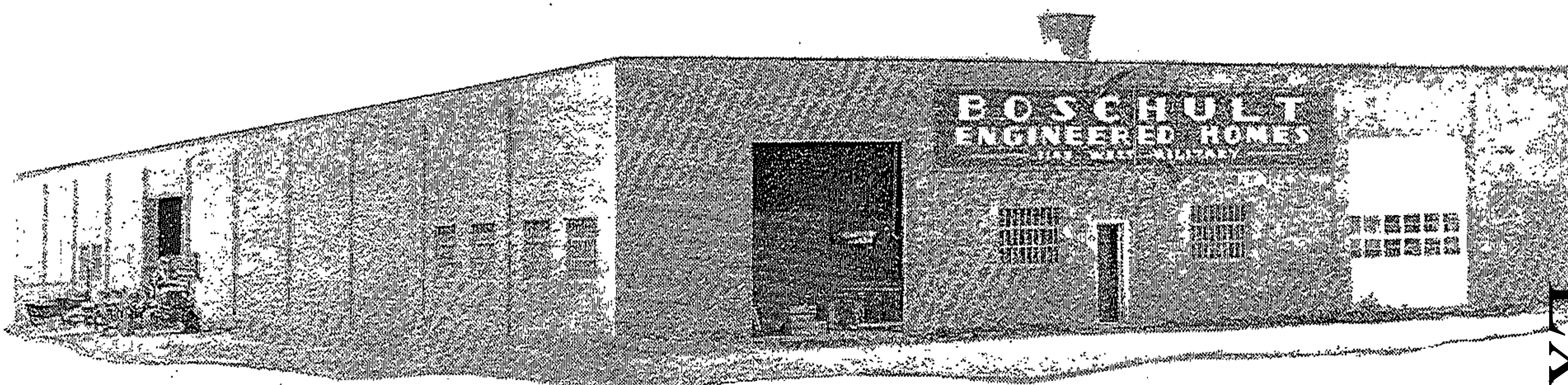
Table 2: Rainfall Intensities

Rainfall intensity does not account for a rainfall's variable intensity over time or across a basin, or for how much rainfall fell prior to the period in question. Designers should keep these factors in mind, especially for areas prone to flash flooding.

IOWA DOT 2015

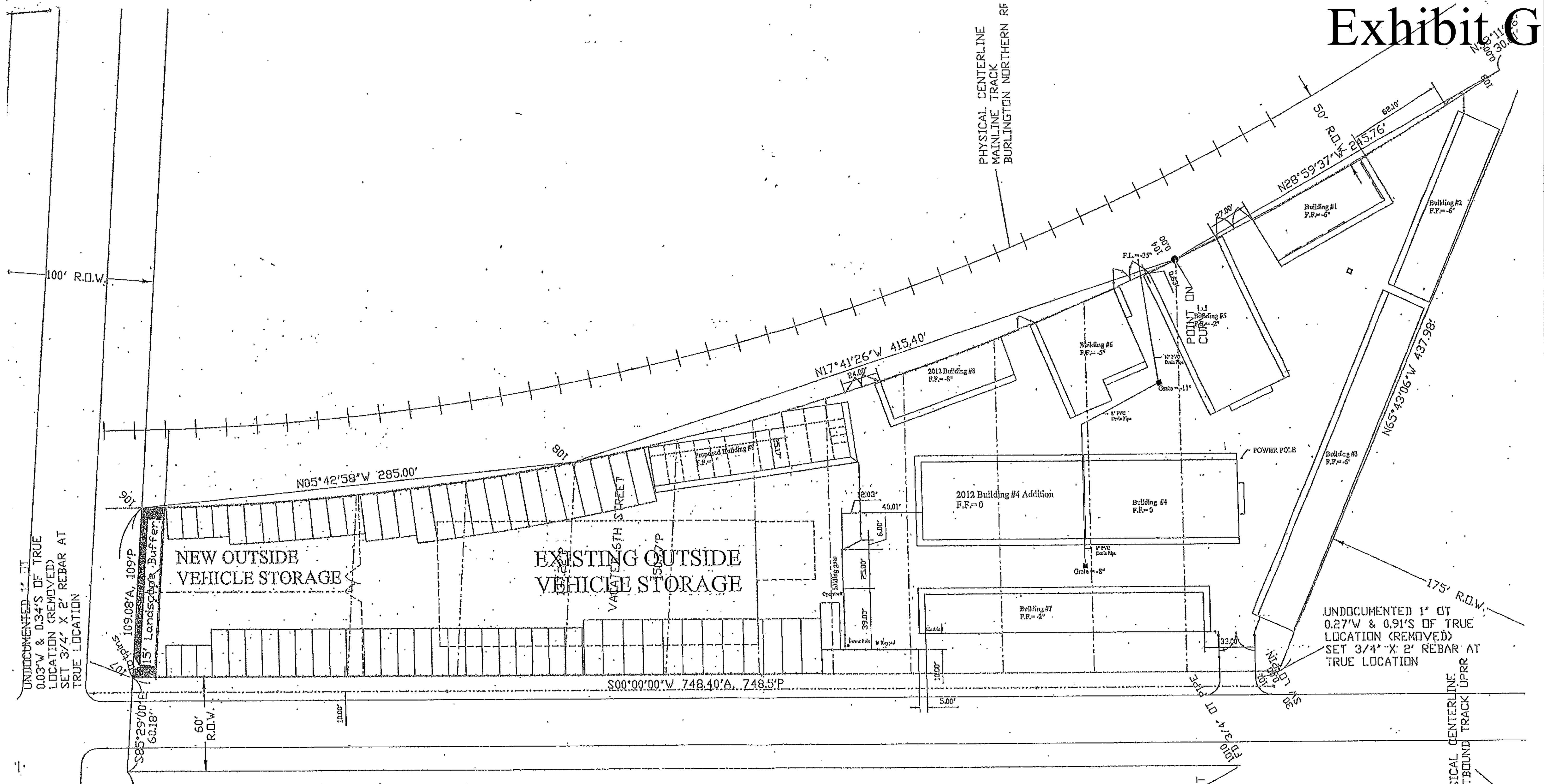
Exhibit F

On the following pages, you will see **how** and **why** this new method of building with factory-assembled sections will help you own a better home . . . at a lower cost.



BOSCHULT FACTORIES include a cabinet-making plant (left) and the fully-equipped prefabricating factory (above).

Exhibit G



2016 MILITARY & PIERCE DEVELOPMENT SITE PLAN

SCALE: 1" = 60

BOSCHULT ENGINEERING CO
340 W. 22nd 721-1017
Fremont, NE 68025

5/3/16

Exhibit H1

To the Office of County Surveyor
Dodge County

LEGAL DESCRIPTION:

ALL OF BLOCK 1 AND BLOCK 2 AND VACATED 6TH STREET LYING BETWEEN SAID BLOCK 1 AND BLOCK 2, ALL IN DOCKSTADER'S ADDITION TO THE CITY OF FREMONT, DODGE COUNTY, NEBRASKA.

N

Scale: 1"=60'

LEGEND

A ACTUAL DISTANCE
R RECORDED DISTANCE
P PLATTED DISTANCE
O FOUND CORNER
● SET 3/4" X 2' REBAR
OT OPEN TOP PIPE

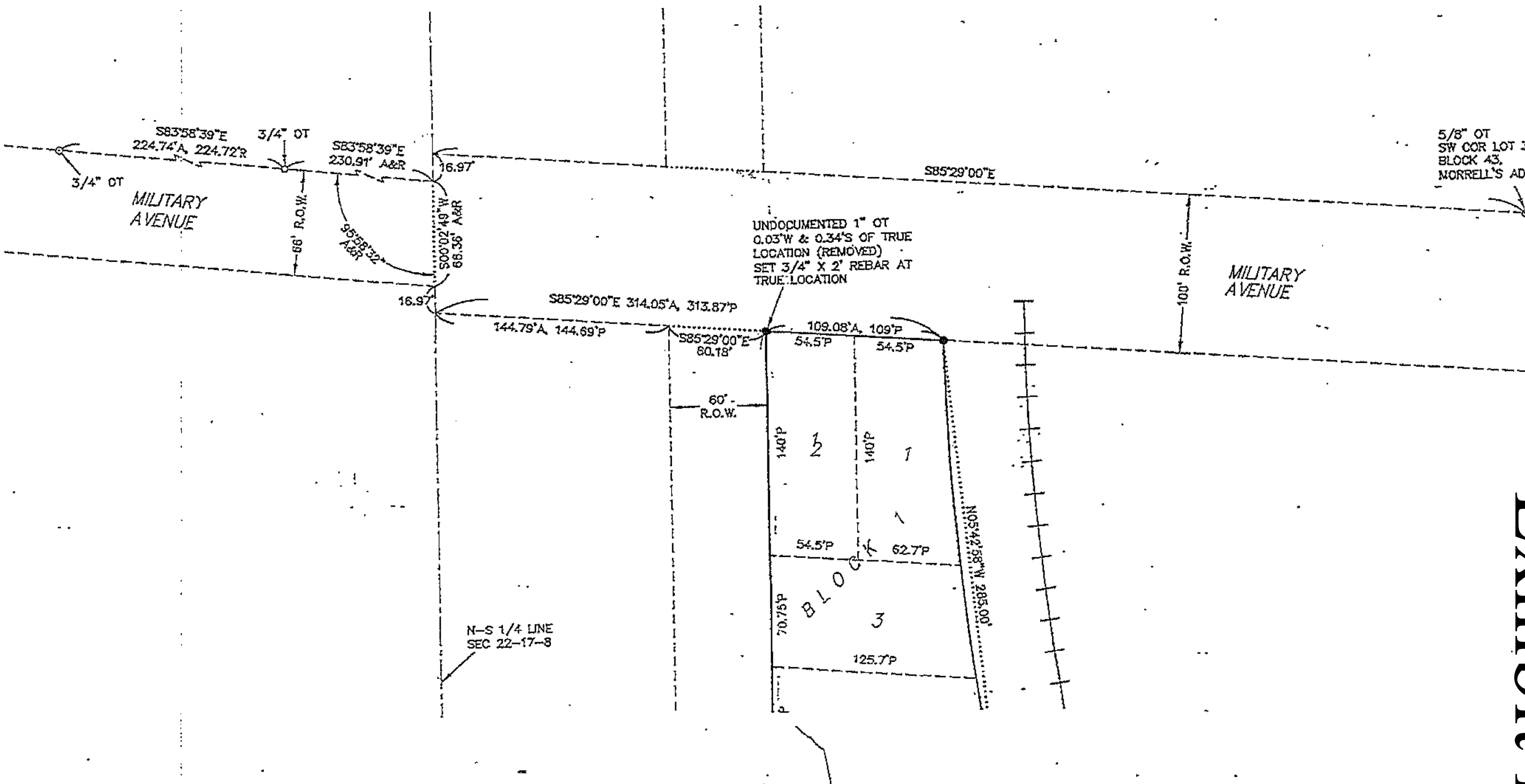
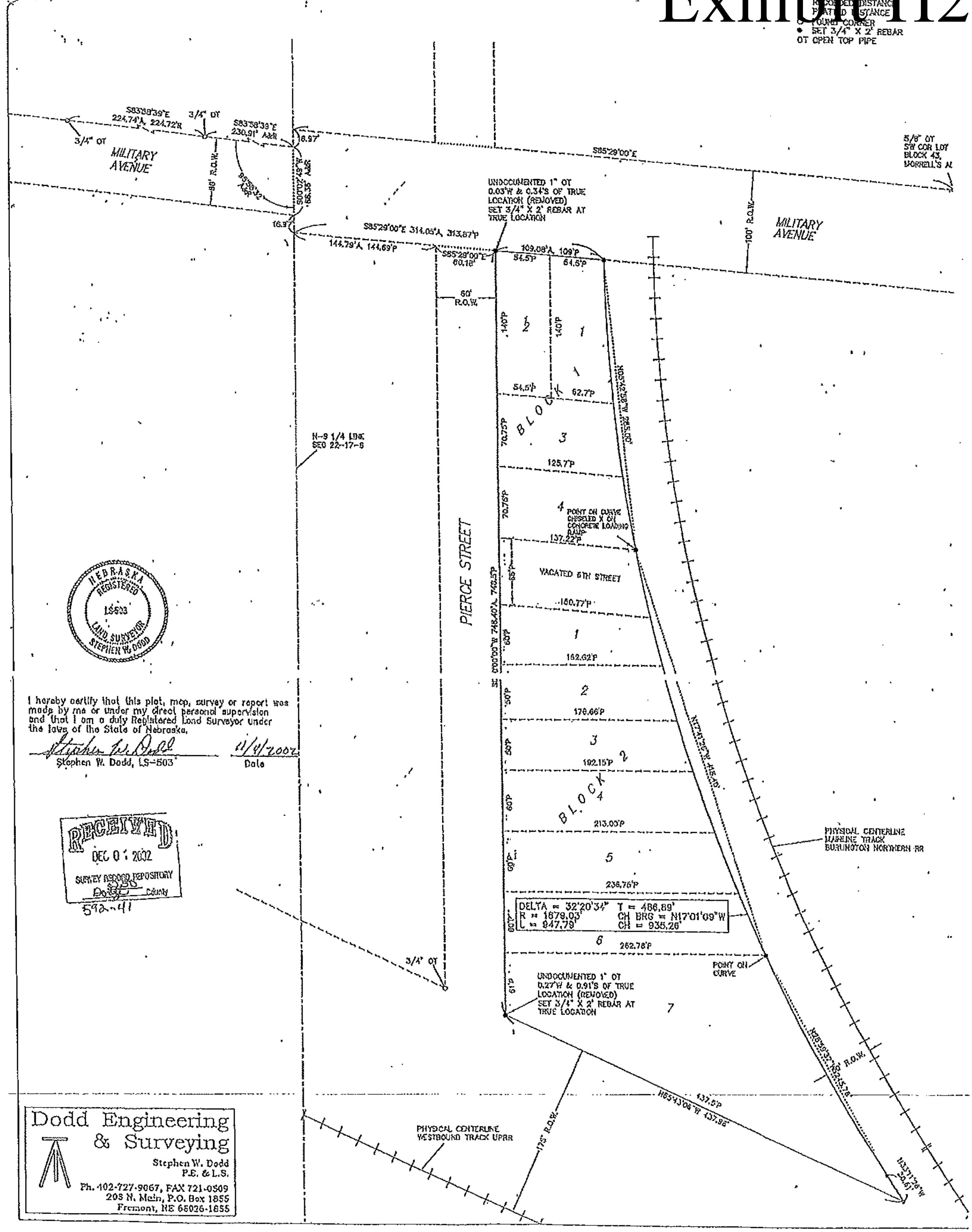


Exhibit H2

ALL OF BLOCK 1 AND BLOCK 2 AND VACATED 6T ET LYING BETWEEN SAID BLOCK 1 AND BLOCK 2, ALL IN D ER'S ADDITION TO THE CITY OF FREMONT, DODGE COU RASKA.



I hereby certify that this plat, map, survey or report was made by me or under my direct personal supervision and that I am a duly Registered Land Surveyor under the laws of the State of Nebraska.

Stephen W. Dodd — 11/4/2002

Stephen W. Dodd, LS-503 — Date

Dodd Engineering & Surveying

Stephen W. Dodd
P.E. & L.S.

Ph. 402-727-9667, FAX 721-0509
203 N. Main, P.O. Box 1855
Fremont, NE 68026-1855

Anderson, Troy

From: Anderson, Troy
Sent: Thursday, April 21, 2016 8:04 AM
To: 'bec@omni-tech.net'
Cc: Don Simon (Donald.Simon@fremontne.gov)
Subject: Site Plan Approval

Dear Mr. Boschult,

After reviewing your site plan, dated April 8, 2016, I have prepared the following comments:

- According to Table 4-3, Fremont Zoning Ordinance (FZO), maximum impervious coverage is limited to 90%
- According to Section 803, FZO, "Landscaping shall be required adjacent to each street property line and within street yards as set forth in Table 8-1."
- According to Section 807, FZO, "In any landscaped area for commercial or industrial uses only required by the Minimum Depth Requirements, the Bufferyard Requirements, or the Parking Lot Interior Landscaping Requirements, one tree of an approved species with a minimum caliper size of two inches shall be planted and maintained for each 500 square feet of required landscaped area. Existing trees approved for preservation shall be counted toward satisfaction of this requirement."
- According to Section 903, FZO, "Parking facilities for each use shall be provided in accord with the minimum requirements set forth in Table 9-1."

While I understand that the bulk of the development is existing, the existing development is clearly nonconforming. With that being said, codes and ordinances of the City do not permit expansion of nonconforming lots, uses, and/or structures. More specifically, according to my calculations (~3.4 acres = ~148,000 square feet * 10% = ~14,800 square feet of pervious cover required) expansion of *vehicle storage (long-term)* into Lots 1 and 2, Block 1, Dockstader's Addition, would exceed the impervious coverage allowance for the development as a whole and therefore would not be permitted.

Generally speaking, I don't have any issue with construction of additional self-storage facilities on Lots 1-7, Block 2, Dockstader's Addition, and the south half of a vacated 6th Street between the east margin of Pierce Street and the west margin of the Chicago, Burlington & Quincy right-of-way, so long as the development plan somewhat resembles that which was presented to the Board of Adjustment back in 2002. Also, I don't have any issue with the continuation of long-term vehicle storage on Lots 3 and 4, Block 1, and Lots 1 – 5, Block 2, Dockstader's Addition, and a vacated 6th Street between the east margin of Pierce Street and the west margin of the Chicago, Burlington & Quincy right-of-way.

Therefore, I am conditionally approving your site plan with the understanding that all of Block 1 and 2, Dockstader's Addition, together with a vacated 6th Street between the east margin of Pierce Street and the west margin of the Chicago, Burlington & Quincy right-of-way, be replatted into one (1) lot (if it hasn't already), and you are able to demonstrate compliance with the maximum impervious coverage requirement prior to issuance of a building permit.

If you have any questions or comments please feel free to contact me directly at (402) 727-2636 or any other method listed below.

Sincerely,

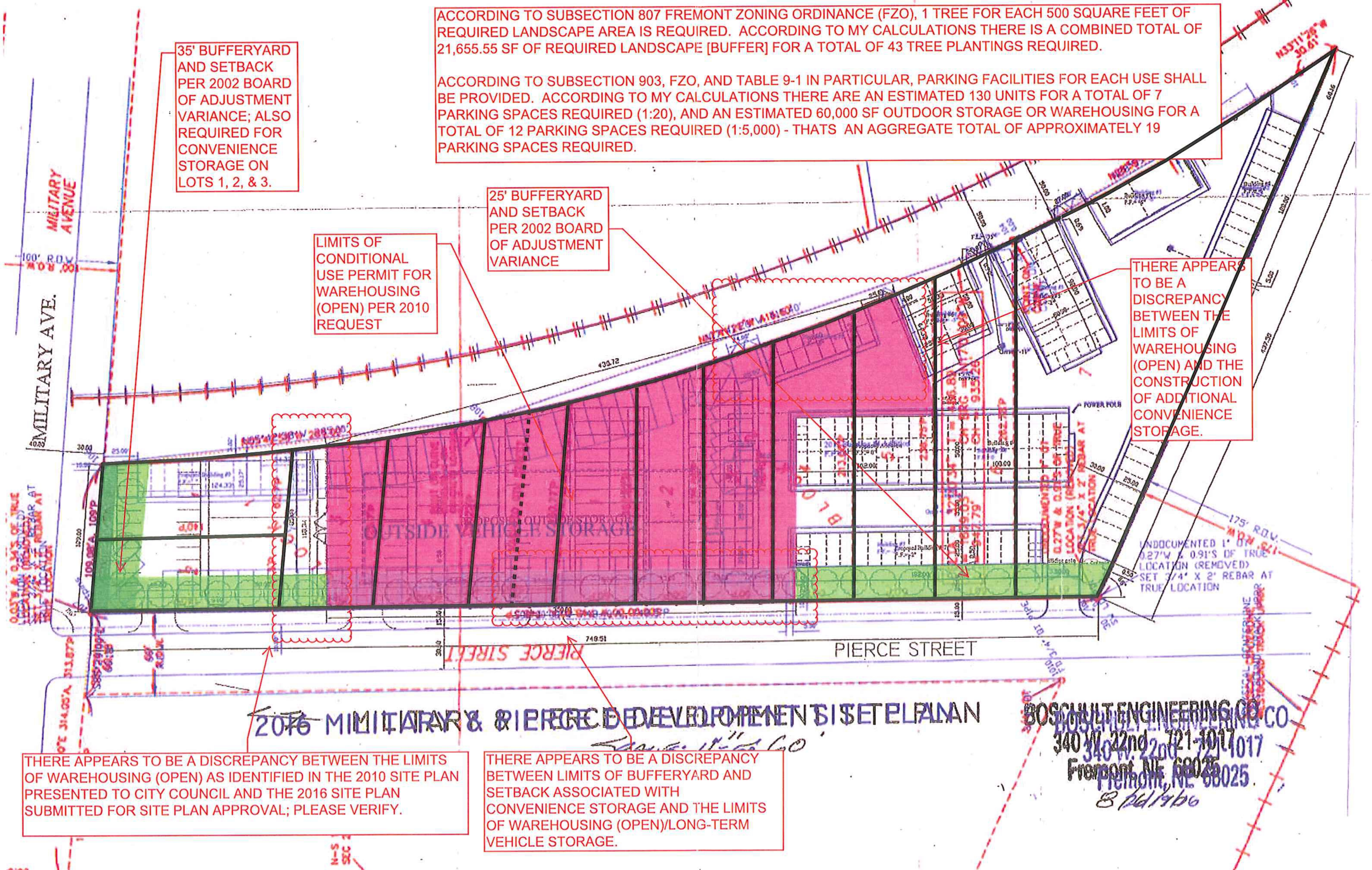
Troy D. Anderson, AICP
Director of Planning
City of Fremont

Exhibit I2

400 E. Military Ave.
Fremont, NE 68025
Phone: (402) 727-2636
Fax: (402) 727-2659
Web: www.fremontne.gov

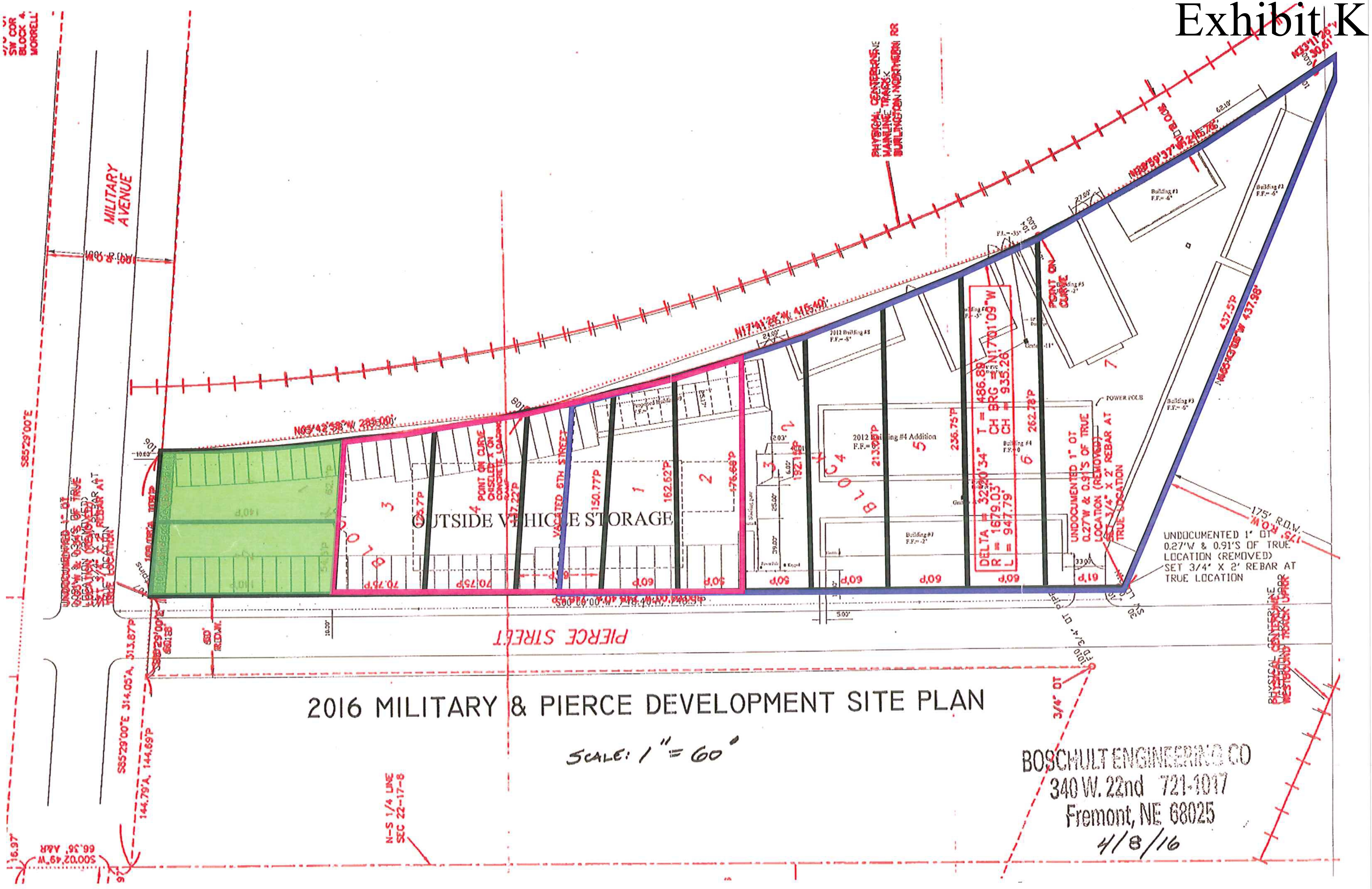
CITY OF
FREMONT
NEBRASKA PATHFINDERS

Exhibit J



ACCORDING TO SUBSECTION 807 FREMONT ZONING ORDINANCE (FZO), 1 TREE FOR EACH 500 SQUARE FEET OF REQUIRED LANDSCAPE AREA IS REQUIRED. ACCORDING TO MY CALCULATIONS THERE IS A COMBINED TOTAL OF 21,655.55 SF OF REQUIRED LANDSCAPE [BUFFER] FOR A TOTAL OF 43 TREE PLANTINGS REQUIRED.
ACCORDING TO SUBSECTION 903, FZO, AND TABLE 9-1 IN PARTICULAR, PARKING FACILITIES FOR EACH USE SHALL BE PROVIDED. ACCORDING TO MY CALCULATIONS THERE ARE AN ESTIMATED 130 UNITS FOR A TOTAL OF 7 PARKING SPACES REQUIRED (1:20), AND AN ESTIMATED 60,000 SF OUTDOOR STORAGE OR WAREHOUSING FOR A TOTAL OF 12 PARKING SPACES REQUIRED (1:5,000) - THATS AN AGGREGATE TOTAL OF APPROXIMATELY 19 PARKING SPACES REQUIRED.
35' BUFFERYARD AND SETBACK PER 2002 BOARD OF ADJUSTMENT VARIANCE; ALSO REQUIRED FOR CONVENIENCE STORAGE ON LOTS 1, 2, & 3.
25' BUFFERYARD AND SETBACK PER 2002 BOARD OF ADJUSTMENT VARIANCE
LIMITS OF CONDITIONAL USE PERMIT FOR WAREHOUSING (OPEN) PER 2010 REQUEST
THERE APPEARS TO BE A DISCREPANCY BETWEEN THE LIMITS OF WAREHOUSING (OPEN) AND THE CONSTRUCTION OF ADDITIONAL CONVENIENCE STORAGE.
MILITARY AVENUE
MILITARY AVE.
100' R.O.W.
OUTSIDE VEHICLE STORAGE
175' R.O.W.
UNDOCUMENTED 1" O.T. 0.27'W & 0.91'S OF TRUE LOCATION (REMOVED) SET 3/4" X 2' REBAR AT TRUE LOCATION
PIERCE STREET
2016 MILITARY & PIERCE DEVELOPMENT SITE PLAN
BOSCHULT ENGINEERING CO
340 W. 22nd 721-1017
Fremont, NE 68025
THERE APPEARS TO BE A DISCREPANCY BETWEEN THE LIMITS OF WAREHOUSING (OPEN) AS IDENTIFIED IN THE 2010 SITE PLAN PRESENTED TO CITY COUNCIL AND THE 2016 SITE PLAN SUBMITTED FOR SITE PLAN APPROVAL; PLEASE VERIFY.
THERE APPEARS TO BE A DISCREPANCY BETWEEN LIMITS OF BUFFERYARD AND SETBACK ASSOCIATED WITH CONVENIENCE STORAGE AND THE LIMITS OF WAREHOUSING (OPEN)/LONG-TERM VEHICLE STORAGE.

Exhibit K



2016 MILITARY & PIERCE DEVELOPMENT SITE PLAN

SCALE: 1" = 60'

BOSCHULT ENGINEERING CO
340 W. 22nd 721-1017
Fremont, NE 68025
4/8/16

Exhibit L1

Office of Design

4A-5

Using the Rational Method to Determine Peak Flow

Design Manual
Chapter 4
Drainage
Originally Issued: 09-01-95
Revised: 07-02-15

This section addresses the following:

- The Rational Method. Note: the Rational Method cannot be used for drainage basins greater than 160 acres.
    - The Rational equation.
    - Drainage area (A).
    - Runoff coefficient (C).
        - Table of runoff coefficients for the Rational Method.
        - Determining a composite C.
    - Rainfall intensity (I).
        - Recurrence interval (frequency).
        - Time of concentration.
            - Overland sheet flow.
            - Shallow concentrated flow.
            - Open channel flow.
- Calculating peak flow (Q) for a drainage area.
- Design application.

Designers need to be aware of work being done by the other offices for the same project site and coordinate with them to determine the design effort required by each office.

The Rational Method

CADD: GEOPAK Drainage can help with the Rational Method calculations. See Section 4A-54, GEOPAK Drainage-Area for instructions.

For most roadway stormwater drainage systems, the Rational Method can be used to determine peak flow (Q). If drainage areas involve pump stations or include topography or structures that retain or detain water, the Rational Method cannot be used. Use other nationally accepted methods.

The Rational Method is limited to drainage basins 160 acres or smaller. This is a result of the assumptions associated with the Rational Method, which include:

- Recurrence interval (T_R) used for estimating peak flow is the same as that for determining rainfall intensity (i.e., a 50 year storm is assumed to produce a 50 year peak flow). Peak flow is assumed to occur when the entire watershed is contributing to flow.
- Rainfall intensity is the same over the entire drainage area and is uniform over a time duration equal to the time of concentration (T_c).

For drainage areas larger than 160 acres, other methods of determining peak flow (for example, the SCS (NCRS) peak flow method) are required. These are discussed in HEC-22.

The Rational Equation

The Rational Method uses the Rational equation given below:

$$Q = CIA \quad \text{(Equation 4A-5\_1)}$$

where:

Q = Peak flow, ft^3/s.

C = Runoff coefficient (dimensionless).

I = Rainfall intensity, in/hr.

A = Drainage area, acres.

Drainage Area (A)

A drainage basin, or watershed, consists of all drainage areas that contribute flow to an outlet. A drainage basin may consist of one or several drainage areas.

For stormwater system design, a drainage area (A) is the combined area of all surfaces that drain to a given location such as a swale, intake or culvert inlet, pond, stream, etc. Following are some questions to investigate when evaluating a drainage area. Local maintenance authorities may be able to provide information. Documentation of the investigation is important:

- How are individual lots graded? Rear to front? Half to the rear and the other half to the front?
- Will existing contour lines remain the same, or are there known intentions for the area be regraded?
- Which direction will water flow down the gutters of the streets?
- At intersections, what direction will bypass flow or ponded flow go; will water flow around the corner or flow across the intersection?
- Will water run the same direction for all design rainfall intensities? Does bypass flow drain to the same downstream location as the underground storm sewer pipe?
- Are there known or expected roof drains, tile drains, subdrains, sump pumps, or other items that drain to the system? Are some of these draining water from other drainage basins?

Quick Tip: Make a preliminary proposed DTM (TIN) file using survey and photogrammetry information to draw drainage areas. Refer to Sections 40A-5 and 40A-6.

Section 4A-2 lists sources that may be useful when examining drainage areas.

Runoff Coefficient (C)

The runoff coefficient (C), also called the “coefficient of imperviousness,” is the ratio of runoff to rainfall. Factors that contribute to C include:

- Shape of the drainage area.
- Slope of the watershed.
- Land use (percentage of impervious surface and surface type).
- Character of the soil.
- Basin storage potential (potholes, roof storage, etc.).
- Previous (antecedent) moisture conditions.
- Interception by vegetation or animal life (e.g. a beaver dam).
- Rainfall duration.
- Rainfall intensity.
- Recurrence interval (rainfall frequency).

Runoff coefficient values for 5 year, 10 year, 50 year, and 100 year recurrence intervals are given in Table 1.

Table 1: Runoff coefficients for the Rational Method.

description of area	runoff coefficient (C)***			
	5 year	10 year	50 year	100 year
Paved Surfaces/Buildings	0.94	0.95	0.98	0.98
Gravel Surfaces, Compacted	0.45	0.50	0.55	0.60
Gravel Surfaces, Loose Graded or Not Compacted	0.35	0.40	0.45	0.50
Industrial Light, 60% Impervious	0.64	0.69	0.79	0.83
Industrial Heavy, 75% Impervious	0.76	0.79	0.86	0.89
Commercial/Business Areas, 85% Impervious	0.81	0.85	0.91	0.92
Residential Row houses/town houses, 65% Impervious	0.66	0.67	0.74	0.76
Residential 1/4 Acre lots, 40% Impervious*	0.48	0.49	0.58	0.62
Residential 1/2 Acre lots, 25% Impervious*	0.36	0.39	0.49	0.54
Residential 1 Acre lots, 20% Impervious*	0.32	0.34	0.46	0.51
Lawn, 0 to 2% slope (flat) **	0.22	0.22	0.30	0.36
Lawn, 2 to 7% slope (average) **	0.24	0.25	0.35	0.40
Lawn, 7% or greater (steep) **	0.26	0.30	0.38	0.45
Parks/Golf Courses/Cemeteries, 8% Impervious	0.21	0.21	0.28	0.34

* Based on Type B soils. Some regions in Iowa have predominant C and D type soils which require larger 'C' values. Appropriate experience is required in selecting appropriate 'C' values. Contact Office of Design Soils Section for further guidance.

** Based on heavy soils and lawn in fair condition. For situations involving sandy soils, contact the Methods Section

*** For higher percent of imperviousness than in the "description of area", developing land with no cover to poor cover, compacted soils, locations of high water table, and/or soils having a slow infiltration rate when thoroughly wetted, these values may be too low. Consult HEC-22, AASHTO Drainage Design Guidelines, or the Methods Section.

If future land use is unknown, the runoff coefficient should be conservatively based.

Occasionally a single C value can adequately describe an entire project or area. Typically, a different C value is required for each inlet and composite C values are often required. When a drainage area is composed of more than one distinct part, use the weighted average equation below to find a composite C.

$$C = \frac{C_1A_1 + C_2A_2 + C_3A_3 ... + ... C_nA_n}{A_1 + A_2 + A_3 ... + ... A_n} \quad \text{(Equation 4A-5\_2)}$$

where:

A_1, A_2, A_3, … A_n = areas of the distinct parts.

C_1 = C value for A_1, C_2 = C value for A_2, etc.

Example Problem 4A-5_1, Determining Composite C

Rainfall Intensity (I)

Rainfall intensity (I) is the average rate of rainfall given in in/hr that occurs over the duration of a storm. Rainfall intensity is required to use the Rational method. To calculate I, the designer must first select a recurrence interval (T_R). Next the designer calculates the time of concentration (T_c). Once T_R and T_c are known, I is determined using Table 2 (for the Rational method, storm duration is the same as T_c). Often, T_c falls between the values in the tables, so I needs to be interpolated.

Table 2: Rainfall Intensities

Rainfall intensity does not account for a rainfall's variable intensity over time or across a basin, or for how much rainfall fell prior to the period in question. Designers should keep these factors in mind, especially for areas prone to flash flooding.

Exhibit L4

Rainfall intensities in Table 2 have been revised to be based on NOAA's Atlas 14. Intensities have increased rather substantially over the Bulletin 71 values previously used, especially for 5 minute, 10 minute, and 15 minute storm durations – in excess of 20% in some cases. This change could impact projects that are in the design process. The following guidance is suggested:

- If the system is downstream from a future project that will be designed using Atlas 14, strongly consider switching to Atlas 14. This review will need to include the potential impacts to the design as well as impacts the changes may have on the upstream system.
- If the system is upstream from a project that will be designed using Atlas 14, consider switching to Atlas 14 if the project is still early in the design process.
- If the system is upstream from a project designed using Bulletin 71 intensities, stay with Bulletin 71 intensities. Contact the Methods Engineer if a copy those intensities are needed.

If you are uncertain what to do, contact the Methods Engineer.

Recurrence Interval (Frequency)

When designing stormwater drainage systems, designers rely on the recurrence interval (T_R). Recurrence interval is referred to in a number of different ways: frequency, design flood frequency, storm frequency, recurrence frequency, exceedence interval, or return period.

Recurrence interval is based on probability:

$$T_R = \frac{1}{p}$$

where:

T_R = Recurrence Interval in years.

p = Probability of a storm event that equals or exceeds a specified flow occurring in a given year.

Table 3: Recurrence interval and probability.

recurrence interval (frequency) T_R	probability of equaling or exceeding flow (X% chance storm) p
2 year	50%
5 year	20%
10 year	10%
25 year	4%
50 year	2%
100 year	1%

Since T_R is based on probability, a recurrence interval is not the actual interval for which a storm event is expected to occur. Instead, it represents the probability a storm event will occur in any given year. For example, a storm event with a 50 year recurrence interval has a 2% probability of equaling or exceeding a specified flow in any given year. A 50 year storm event may actually occur several times in a 50 year span, several times in one year, or just once in 100 years. When communicating with or relating to the general public, using terms such as "X% Chance Storm Event" may help reduce confusion and concerns.

Designing a stormwater drainage system to handle the worst storm event that could happen would likely be too costly for most situations. On the other hand, designing a system that is overtaxed by even minor storm events can result in flooding that creates safety issues or economic hardships. Since the consequences of flooding in some areas are more severe than in others, desired design T_R values vary for different elements of a system depending on the area drained, area conveying the runoff, and the need to avoid flooding. The selection of the design T_R is based on several factors, which can include safety, economics, policy, or regulatory requirements. The goal is to balance the cost of the system with potential risk and damage costs.

Interstates, Freeways, Expressways, and Primary Highways

Table 4 provides minimum required design T_R values for interstates, freeways, expressways, and primary highways. More stringent requirements (higher design recurrence intervals) may be necessary in areas where encroachment or ponding can result in traffic delays, property damage, or safety concerns.

Table 4: Required minimum design recurrence interval values

situation	design recurrence interval	X% chance storm
flushing velocity	5 year	20%
intake on continuous grade	10 year	10%
intake at a sag point	50 year	2%
major design storm	100 year	1%

Staged Construction or Detour

Recurrence interval design values selected for staged construction and detours depend on traffic counts, speeds, how long the system will be in place, accommodations for overtopping or bypassed flow, and the consequences should the system be overtaxed. Two years is the minimum recurrence interval design value allowed for temporary staged construction.

Local Streets

Recurrence interval design values for local jurisdictions vary throughout the state. Contact the local jurisdiction.

For reconstruction projects involving storm sewer, existing systems should be analyzed and new systems should be sized using current recurrence intervals even if the original system (and other systems tying into it) was sized using a smaller recurrence interval.

In using the Rational equation to determine peak flow for a given T_R (e.g. 10 year), the same T_R must be used when determining C and I. Occasionally the contributing drainage area A is affected by the T_R as well, due to an increased chance of flow bypassing from one watershed to another during large recurrence interval events.

Time of Concentration (T_c)

Time of concentration (T_c) is the time required for water falling on the hydraulically most remote point in a drainage area to flow to the point of interest. Remoteness relates to time rather than distance. Factors affecting T_c include:

- **Surface roughness.** Rough terrain, such as undeveloped areas, impedes flow of runoff more than smooth surfaces such as pavement. This increases T_c.
- **Channel shape and flow patterns.** Channels typically convey runoff more efficiently than flat terrain. This reduces T_c.
- **Slope.** The velocity of runoff increases with increase in slope. This reduces T_c.

Water traveling a short distance across rough, flat terrain may require more time to reach a point of interest than water traveling a longer distance across smooth, steep terrain. Thus, the most hydraulically distant point in a drainage area may not be the point located furthest from the point of interest.

Exhibit L6

Total T_c may consist of several components and is calculated as follows:

$$T_c = T_{c\ sheet} + T_{c\ shallow} + T_{open\ channel} \quad \text{(Equation 4A-5\_3)}$$

where:

T_c = Total time of concentration, minutes.

$T_{c\ sheet}$ = Time of concentration for overland sheet flow, minutes.

$T_{c\ shallow}$ = Time of concentration for shallow concentrated flow, minutes.

$T_{c\ open\ channel} = T_{c\ gutter} + T_{c\ pipe} + T_{c\ swale}$.

where:

$T_{c\ gutter}$ = Time of concentration for gutter flow, minutes.

$T_{c\ pipe}$ = Time of concentration for pipe flow, minutes.

$T_{c\ swale}$ = Time of concentration for flow in a swale, minutes

When calculating I, use a minimum total T_c of 5 minutes.

The following worksheet will aid with calculating T_c. The components of the worksheet are further explained below.

Time of Concentration Worksheet

Peak discharge is greatly affected by watershed slope and velocity, so reasonable care and calculations are required to estimate slope for each type of flow. Best results are generally obtained when the slope derived is representative of the areas to which it is being applied. Drainage areas may need to be divided into sub-basins of significantly different topographical elements.

Overland Sheet Flow ($T_{c\ sheet}$)

Overland sheet flow is the shallow mass of runoff over plane surfaces (e.g. parking lots, lawns). Overland sheet flow usually occurs over a short distance at the high end of a drainage area. The National Resources Conservation Service (NRCS) recommends limiting overland sheet flow to 100 feet for unpaved areas. This manual follows the recommendation of NRCS. For paved surfaces, the maximum is 300 feet.

$L_{Tc\ sheet}$ = 100 feet maximum for unpaved areas and 300 feet maximum for paved areas.

Use the kinematic wave equation below to estimate T_c for overland sheet flow:

$$T_{c\ sheet} = \frac{K_u}{I^{0.4}}\left(\frac{nL}{\sqrt{S}}\right)^{0.6} \quad \text{(Equation 4A-5\_4)}$$

where:

$T_{c\ sheet}$ = Overland sheet flow travel time, minutes.

K_u = Empirical coefficient equal to 0.933.

n = Manning's roughness coefficient for overland flow (see Table 5), based on very shallow flow depths of up to 0.1 feet.

L = Overland flow path length, ft.

I = Rainfall intensity rate, in/hr.

S = Slope of the overland flow path, ft/ft.

Table 5: Manning's roughness coefficient (n) for overland flow.

surface description	n
Asphalt and concrete: new existing	 0.016 Refer to Table 2 of Section 4A-6
Cement rubble surface	0.024
Fallow (no residue)	0.05
Cultivated soils: residue cover ≤ 20% residue cover > 20% range (natural)	 0.06 0.17 0.13
Grass: short grass prairie (fields) dense grasses (lawns)	 0.15 0.24
Woods: light underbrush dense underbrush	 0.40 0.80

Table 2 will be necessary to calculate $T_{c\ sheet}$. Since both T_c and I are unknowns, a trial and error process is required using the rainfall intensity values in Table 2. This is how it works:

1. Refer to Table 2 to determine which Section code is appropriate. Choose a value from the "duration" column (this serves as $T_{c\ sheet}$) in Table 2 with the corresponding I from the appropriate "recurrence interval" (10 year or 50 year) column.
2. Calculate $T_{c\ sheet}$ by substituting I into Equation 4A-5_4.
3. Compare the selected value of $T_{c\ sheet}$ with the calculated value from Step 2.
   - If the value of $T_{c\ sheet}$ from Step 2 is less than 5 minutes, use $T_{c\ sheet}$ = 5 min.
   - If the selected $T_{c\ sheet}$ is within one minute of $T_{c\ sheet}$ from Step 2, then $T_{c\ sheet}$ equals the selected value.
   - If the selected $T_{c\ sheet}$ is not within one minute of $T_{c\ sheet}$ from Step 2, then select another value for $T_{c\ sheet}$ (try a value close to the calculated $T_{c\ sheet}$). This may require using values of T_{csheet} not in the tables. If this is the case, I will need to be interpolated. This process is demonstrated in the Sheet Flow Example Problem.
4. Repeat Steps 2 and 3 until the selected value for $T_{c\ sheet}$ is within one minute of the calculated $T_{c\ sheet}$.

Example Problem 4A-5_2. Overland Sheet Flow

Shallow Concentrated Flow ($T_{c\ shallow}$)

After a short distance (depending on ground cover, but always less than 100 feet), overland sheet flow starts to concentrate in rills, and then in gullies. This flow is referred to as shallow concentrated flow. The velocity of this flow is estimated using a relationship between velocity and slope. To calculate $T_{c\ shallow}$, first estimate the velocity of flow using the following equation:

$$V = K_u k \sqrt{S} \quad \text{(Equation 4A-5\_5)}$$

where:

V = Velocity of flow, ft/s.

S = Slope, ft/ft.*

k = Intercept coefficient (see Table 6).

K_u = Units conversion factor*, 33.

*HEC-22 bases slope on percent. Units conversion factors in HEC-22 are smaller by a factor of 10.

Table 6: Intercept coefficients for shallow concentrated flow.

land cover/flow regime	k
Forest with heavy ground litter; hay meadow (overland flow)	0.076
Trash fallow or minimum tillage cultivation; contour or strip cropped; woodland (overland flow)	0.152
Short grass pasture (overland flow)	0.213
Cultivated straight row (overland flow)	0.274
Nearly bare and untilled (overland flow)	0.305
Grassed waterway (shallow concentrated flow)	0.457
Unpaved (shallow concentrated flow)	0.491
Paved area (shallow concentrated flow); small upland gullies	0.619

Once velocity has been determined, use the equation below to calculate $T_{c\ shallow}$.

$$T_{c\ shallow} = \frac{L}{60V} \quad \text{(Equation 4A-5\_6)}$$

where:

$T_{c\ shallow}$ = Shallow concentrated flow travel time, minutes.

L = Flow length, ft.

V = Velocity of flow, ft/s.

Example Problem 4A-5_3, Shallow Concentrated Flow

Open Channel Flow

Open channels for roadway stormwater drainage systems consist of drainage swales, pipes flowing partially full, and gutters.

Gutter Flow ($T_{c\ gutter}$)

Flow time for runoff in the gutter is typically small (1 to 2 minutes, or less) compared to the total T_c, and it is often not included. This produces slightly more conservative results for rainfall intensity, which adds in a factor of safety.

For long gutter lengths (several hundred feet), flat gutter slopes (around or less than 0.50%), or low flows (less than 0.50 ft^3/s), gutter flow time may be several minutes and may need to be included in total (T_c). To estimate gutter flow time, first determine the average velocity using one of the equations below:

$$V = \frac{2Q}{T^2 S_x} \quad \text{(Equation 4A-5\_7, uniform cross section)}$$

$$V = \frac{2Q}{T^2 S_x + W^2 (S_W - S_x)} \quad \text{(Equation 4A-5\_7, composite gutter section)}$$

where:

Q = Flow in gutter, ft^3/s.

T = Spread, ft.

W = Width of depressed section, ft.

S_x = Cross slope of pavement, ft/ft.

S_W = Cross slope of depressed gutter section, ft/ft.

After calculating velocity, use Equation 4A-5_6 to determine ($T_{c\ gutter}$).

Pipe Flow ($T_{c\ pipe}$)

Refer to General Information for Pipe Design in Section 4A-10.

Drainage Swales ($T_{c\ swale}$)

Use Manning's equation (Equation 4A-5_8 below) to estimate average flow velocity. The Manning's roughness coefficient 'n' is a function of several parameters including: channel material type, roughness, thickness (such as size of rocks or height of vegetation), flow velocity and flow depth. This coefficient can have a dramatic result in the outcome of the equation. Table 7 provides a brief list of some average 'n' values for consideration in the design process. The designer should have a good understanding of how and when to use this equation and how to evaluate the use of an appropriate 'n' value before proceeding.

$$V = \frac{K_u}{n}\left(\frac{A}{P_{wetted}}\right)^{0.67}\sqrt{S} \quad \text{(Equation 4A-5\_8)}$$

where:

V = Velocity of flow, ft/s.

S = Slope, ft/ft.

n = Manning's roughness coefficient for open channel flow (See Table 7).

K_u = Units conversion factor, 1.49.

A = Cross sectional flow area, ft^2.

P_{wetted} = Wetted perimeter (surface in contact with water), ft.

Table 7: Values of Manning's coefficient (n) for open channel flow.

channel material	Manning's n
Concrete	
trowel finish	0.013
float finish	0.015
Concrete bottom with rubble or riprap sides	0.030
Vegetation	
depth of flow up to 0.7 ft (215 mm)	
lawns cut 4 to 6 inches	0.070
good stand cut to 12 inches	0.140
good stand cut to 24 inches	0.250
fair stand cut to 12 inches	0.120
fair stand cut to 24 inches	0.200
depth of flow 0.7 to 1.5 ft (215 to 450 mm)	
lawns cut 4 to 6 inches	0.050
good stand cut to 12 inches	0.100
good stand cut to 24 inches	0.150
fair stand cut to 12 inches	0.080
fair stand cut to 24 inches	0.140
Bare soil	
recently completed	0.018
clean after weathering	0.022
Rock cut	
smooth and uniform	0.035
jagged and irregular	0.040

After calculating velocity, use Equation 4A-5_5 to determine ($T_{c\ swale}$).

To estimate $T_{c\ swale}$, the design flow, Q, is desired to estimate flow depth in order to estimate wetted perimeter (P_{wetted}). However, T_c is required to estimate Q; therefore, this is an iterative process that is simplified by hydraulic computer models and spreadsheets. The general design process should be understood before using a model and checking results.

Exhibit L10

Calculating Peak Flow (Q) for a Drainage Area

The following example demonstrates the process for determining peak flow for a drainage area.

Example Problem 4a-05_4, Determining Peak Flow Values

Design Application

Distinct parts of a drainage area may produce higher peak flows than if a composite 'C' value is used for the total drainage area. Each of these parts should be examined individually, as well as in combination, to determine which produces the largest peak flow. When determining Q for the composite area, use the flowpath associated with the longest T_c.

Runoff analysis must consider flow from outside the study area that may enter the site either as surface runoff or as contained flow in tiles and pipes.

In addition to the determination and analysis of existing and proposed design flows for each design event, consideration must be given to interim construction conditions, staged construction, and reconstruction

Interim Construction Conditions

During construction, vegetative cover may be diminished resulting in increased runoff coefficients and peak flows. Proposed design flow determinations may not be adequate to evaluate interim construction conditions (including erosion and sediment control needs).

Inlets are generally protected from sediment by erosion control devices, such as filter socks, which can trap runoff. Evaluate potential ponding and impacts caused by such erosion control devices.

Sediment basins may be desired to both store excess runoff and capture excess sediment.

Staged Construction

Designers occasionally need to select temporary drainage structures to accommodate staged construction. The level of design required must be commensurate with the risks (including traffic, speed, location, etc.) and should be discussed and selected by the design team.

Reconstruction

Generally reconstruction results in replacing or upgrading a storm sewer system. Occasionally the contributing runoff area has been modified either by overland contribution or closed system contribution (from other storm drain systems that have been tapped into the project area system). Quite often design parameters (e.g. design flow) and design coefficients (impervious area) have changed since the original system design. However, don't reduce the number or size of existing inlets or pipes without significant design evaluation and concurrence from the local and maintenance authorities.

Exhibit L11

Chronology of Changes to Design Manual Section:

004A-005 Using the Rational Method to Determine Peak Flow

7/2/2015	Revised	
	Revised Rainfall Intensity tables to NOAA-14 data. Deleted metric information. Revised Example problems 4A-5_2 and 4A-5_4.	
11/30/2010	Revised	
	Rewritten material from old 4A-4. Material in old 4A-5 moved to 4A-6.	